Contents

Preface ix

SECTION I. GROWTH AND CHARACTERIZATION

I.A. In-situ characterization

In-situ monitoring and control of surface processes in metalorganic vapor phase epitaxy by surface photo-absorption (invited paper)
N. Kobayashi 1
Characterization of GaInP layers grown on GaAs substrates monitored by surface photo-absorption
H. Yanagisawa, T. Tanaka and S. Minagawa 12
Effect of strain on source gas decomposition and group V desorption in metalorganic vapor phase epitaxy studied by surface photo-absorption
Y. Kobayashi and N. Kobayashi 17
GaAs (001) surface balanced with arsine partial pressure in metalorganic chemical vapor deposition reactor observed by surface photoabsorption
A. Sakamoto, S. Otake, M. Yamamoto and I. Iwasa 22
Monitoring of gas-phase species in metalorganic vapor phase epitaxy by fiber-optics based Fourier transform infrared spectroscopy
S. Salim, K.F. Jensen and R.D. Driver 28
Efficiency of arsenic and phosphorus precursors investigated by reflectance anisotropy spectroscopy
P. Kurpas, J. Jönsson, W. Richter, D. Gutsche, M. Pristovsek and M. Zorn 36
Surface processes before and during growth of GaAs (001)
K. Ploska, J.-Th. Zettler, W. Richter, J. Jönsson, F. Reinhardt, J. Rumberg, M. Pristovsek, M. Zorn, D. Westwood and R.H. Williams 44
In-situ reflectance anisotropy studies of ternary III–V surfaces and growth of heterostructures
M. Zorn, J. Jönsson, A. Krost, W. Richter, J.-Th. Zettler, K. Ploska and F. Reinhardt 53
In situ control of the growth of GaAs/GaAlAs structures in a metalorganic vapour phase epitaxy reactor by laser reflectometry
R. Azoulay, Y. Raffle, R. Kuszelewicz, G. Le Roux, L. Dugrand and J.C. Michel 61
Observation of a new in-situ optical minitoring signal with monolayer resolution in metalorganic molecular beam epitaxy and metalorganic vapor phase epitaxy of wide-gap II–VI compounds
A. Yoshikawa, M. Kobayashi and S. Tokita 68
A study of the growth kinetics of II–VI metalorganic vapour phase epitaxy using in situ laser reflectometry
S.J.C. Irvine and J. Bajaj 74

I.B. Growth mechanism

Temperature dependence of solid–vapor compositional relation in epitaxial growth of $GaAs_xSb_{1-x}$ by low-pressure metalorganic chemical vapor deposition
Y. Iwamura, T. Takeuchi and N. Watanabe 82
Intermediate range between N-doped GaP and $GaP_{1-x}N_x$ alloys: difference in optical properties
S. Miyoshi, H. Yaguchi, K. Onabe, R. Ito and Y. Shiraki 87
Growth of GaP by cold-wall metalorganic-chloride vapor phase epitaxy
Y. Miura, S. Ushijima, N. Takahashi, A. Koukitu and H. Seki 93
Growth of GaAsN by low-pressure metalorganic chemical vapor deposition using plasma-cracked N_2
M. Sato 99

Do gas phase adducts form during metalorganic vapour phase epitaxial growth of gallium arsenide?
D.F. Foster, C. Glidewell, D.J. Cole-Hamilton, I.M. Povey, R.D. Hoare and M.E. Pemble 104
Behavior and mechanism of wide terrace formation during metalorganic vapor phase epitaxy of GaAs and related materials
M. Shinohara, M. Tanimoto, H. Yokoyama and N. Inoue 113
Scanning tunneling microscopy study of two-dimensional nuclei on GaAs grown by metalorganic chemical vapor deposition
M. Kasu and N. Kobayashi 120
Step-bunching in $(Al_xGa_{1-x})_{0.5}In_{0.5}P$ layers on misoriented (001) GaAs substrates grown by metalorganic vapor phase epitaxy
A. Gomyo, H. Hotta, F. Miyasaka, K. Tada, H. Fujii, K. Fukagai, K. Kobayashi and I. Hino 126
Multistep formation and lateral variation in the In composition in InGaAs layers grown by metalorganic vapor phase epitaxy on (001) vicinal GaAs substrates
K. Hiramoto, T. Tsuchiya, M. Sagawa and K. Uomi 133
Order/disorder heterostructure in $Ga_{0.5}In_{0.5}P$ with $\Delta E_g = 160$ meV
L.C. Su, I.H. Ho, N. Kobayashi and G.B. Stringfellow 140

SECTION II. WIDE BANDGAP III–V MATERIALS AND OXIDES

II.A. Wide bandgap phosphides

Mechanism of Zn passivation in AlGaInP layer grown by metalorganic chemical vapor deposition
K. Kadoiwa, M. Kato, T. Motoda, T. Ishida, N. Fujii, N. Hayafuji, M. Tsugami, T. Sonoda, S. Takamiya and S. Mitsui 147
The deep levels in InGaAlP epilayers grown by metalorganic chemical vapor deposition using tertiarybutylphosphine
T. Izumiya, H. Ishikawa and M. Mashita 153
Comparison of alternate P-sources to phosphine in the metalorganic vapor phase epitaxy growth of p-AlGaInP
M. Mannoh, A. Ishibashi and K. Ohnaka 158
Structural characterization of lattice-mismatched InGaP layers by the ion channeling method
C. Nozaki, T. Noda, S. Fujita and Y. Ashizawa 164
Characterization of ordered and disordered $Ga_{0.51}In_{0.49}P$ domains by micro Raman spectroscopy
A. Krost, N. Esser, H. Selber, J. Christen, W. Richter, D. Bimberg, L.C. Su and G.B. Stringfellow 171
Growth of high-quality InAlP/InGaP quantum wells and InAlP/InGaP superlattice barrier cladding layers by metalorganic chemical vapor deposition
R.V. Chelakara, M.R. Islam, J.G. Neff, K.G. Fertitta, A.L. Holmes, F.J. Ciuba and R.D. Dupuis 179
Photoluminescence process in AlP/GaP short period superlattices grown by organometallic vapor phase epitaxy using tertiarybutylphosphine
A. Wakahara, Y. Nabetani, X.-L. Wang and A. Sasaki 187

II.B. Nitrides and oxides

Metalorganic vapor phase epitaxy growth and characteristics of Mg-doped GaN using GaN substrates
T. Detchprohm, K. Hiramatsu, N. Sawaki and I. Akasaki 192
Surface orientation dependence of growth rate of cubic GaN
M. Nagahara, S. Miyoshi, H. Yaguchi, K. Onabe, Y. Shiraki and R. Ito 197
X-ray photoelectron spectroscopy study of GaN and GaP surfaces annealed in PH_3 and NH_3 and metalorganic chemical vapor deposition growth of GaN/GaP heterostructures
Y. Ueta, H. Sato, S. Sakai and M. Fukui 203
Metalorganic vapor phase epitaxy growth of $(In_xGa_{1-x}N/GaN)^n$ layered structures and reduction of indium droplets
M. Shimizu, K. Hiramatsu and N. Sawaki 209
A study on strong memory effects for Mg doping in GaN metalorganic chemical vapor deposition
Y. Ohba and A. Hatano 214
Preparation and electrical properties of ferroelectric $(Pb,La)(Zr,Ti)O_3$ thin films by metalorganic chemical vapor deposition (invited paper)
K. Tominaga, Y. Sakashita, H. Nakashima and M. Okada 219
Effects of the utilization of a buffer layer on the growth of $Pb(Zt,Ti)O_3$ thin films by metalorganic chemical vapor deposition
M. Shimizu, M. Sugiyama, H. Fujisawa, T. Hamano, T. Shiosaki and K. Matsushige 226
Atomic layer controlled metalorganic chemical vapor deposition of superconducting $YBa_2Cu_3O_x$ films
S. Oda, H. Zama and S. Yamamoto 232

SECTION III. SELECTIVE AREA GROWTH

Highly selective InGaAs growth by metalorganic chemical vapor deposition with a high-speed rotating susceptor
M. Ida, K. Kurishima and T. Kobayashi 237
Selective area epitaxy of GaInAs using conventional and novel group III precursors
F. Scholz, D. Ottenwälder, M. Eckel, M. Wild, G. Frankowsky, T. Wacker and A. Hangleiter 242
1.24–1.66 μm quantum energy tuning for simultaneously grown InGaAs/InP quantum wells by selective-area metalorganic vapor phase epitaxy
M. Suzuki, M. Aoki, T. Tsuchiya and T. Taniwatari 249
Analysis of the in-plane bandgap distribution in selectively grown InGaAs/InGaAsP multiple quantum well by low pressure metalorganic chemical vapor deposition
T. Itagaki, T. Kimura, K. Goto, Y. Mihashi, S. Takamiya and S. Mitsui 256
New selective metalorganic chemical vapor deposition growth method for InAlAs with high aluminum composition
M. Kushibe and K. Takaoka 263
Simulation of species transport during growth of compound semiconductors over patterned substrates
Yu.N. Makarov, M.S. Ramm, E.A. Subashieva and A.I. Zhmakin 271
Model for in-situ etching and selective epitaxy of $Al_xGa_{1-x}As$ with HCl gas by metalorganic vapor phase epitaxy
K. Fujii, K. Shimoyama, H. Miyata, Y. Inoue, N. Hosoi and H. Gotoh 277
Facet growth of $Al_xGa_{1-x}As$ with HCl gas by metalorganic vapor phase epitaxy
K. Shimoyama, N. Hosoi, K. Fujii and H. Gotoh 283
Metalorganic vapor phase epitaxy growth of InGaP using tertiarybutylphosphine and its application to selective regrowth of current blocking layers of laser diodes
M. Horita, M. Usami and Y. Matsushima 291
GaAs vertical and lateral growth enhancement using trimethylgallium and trimethylarsenic in selective area metalorganic vapor phase epitaxy on a (111)B substrate
Y. Le Bellégo, S. Tomioka and H. Kawai 297
Selective area metalorganic chemical vapor deposition growth for hexagonal-facet lasers
S. Ando, N. Kobayashi and H. Ando 302
Dynamics of selective metalorganic vapor phase epitaxy growth for GaAs/AlGaAs micro-pyramids
K. Kumakura, K. Nakakoshi, M. Kishida, J. Motohisa, T. Fukui and H. Hasegawa 308

SECTION IV. LATTICE MISMATCHED EPITAXY

Defect reduction in GaAs and InP grown on planar Si(111) and on patterned Si(001) substrates
A. Krost, R.F. Schnabel, F. Heinrichsdorff, U. Rossow, D. Bimberg and H. Cerva 314
Stress distribution and dislocation dynamics in GaAs grown on Si by metalorganic chemical vapor deposition
Y. Naoi, S. Kurai, S. Sakai, T. Yang and Y. Shintani 321
Highly strained $In_{0.5}Ga_{0.5}P$ as wide-gap material on InP substrate for heterojunction field effect transistor application
F. Scheffer, A. Lindner, Q. Liu, C. Heedt, R. Reuter, W. Prost, H. Lakner and F.J. Tegude 326
Atomic layer epitaxy and characterization of InP and InAs/InP heterostructures
C.A. Tran, R.A. Masut, J.L. Brebner, M. Jouanne, L. Salamanca-Riba, C.C. Shen, B. Sieber and A. Miri 332
Study of threading dislocation reduction by strained interlayer in InP layers grown on GaAs substrates
Y. Okuno and T. Kawano 338
Investigation of strain effects in selectively grown GaAs on Si
K. Zieger, P. Stauss, G. Frankowsky, A. Hangleiter, F. Scholz and J. Spitzer 345
Metalorganic chemical vapor deposition growth of GaAs on annealed Si in H_2
A. Jono, A. Tachikawa, T. Aigo and A. Moritani 353
High-resolution transmission electron microscopy characterization of III–V compounds on Si grown by metalorganic chemical vapor deposition
T. Soga, T. Jimbo and M. Umeno 358
Growth of GaSb on GaAs substrates
R.M. Graham, A.C. Jones, N.J. Mason, S. Rushworth, L. Smith and P.J. Walker 363
Investigation of effect of strain-compensated structure and compensation limit in strained-layer multiple quantum wells
T. Tsuchiya, M. Komori, R. Tsuneta and H. Kakibayashi 371
Lattice relaxation in large mismatch systems of (111)CdTe/(100)GaAs and (133)CdTe/(211)GaAs layers
K. Shigenaka, L. Sugiura, F. Nakata and K. Hirahara 376

SECTION V. DOPING FOR p-, n- AND SEMI-INSULATING LAYERS

Carbon doping in metalorganic vapor phase epitaxy (invited paper)
T.F. Kuech and J.M. Redwing 382
Dependence of carbon incorporation on crystallographic orientation during metalorganic vapor phase epitaxy of GaAs and AlGaAs
M. Kondo and T. Tanahashi 390
Study of silicon incorporation from SiH_4 in GaAs layers grown by metalorganic vapor phase epitaxy using tertiarybutylarsine
J.M. Redwing, H. Simka, K.F. Jensen and T.F. Kuech 397
Thermal stability of highly Se-doped specular surface of $In_{0.5}Ga_{0.5}As$ grown by low-pressure metalorganic vapor phase epitaxy
T. Tsuchiya, H. Nagai, T. Meguro and H. Sakaguchi 403
Si-doping in GaAs grown by metalorganic vapor phase epitaxy using tertiarybutylarsine and tetraethylsilane
T. Tanabe, H. Matsubara, A. Saegusa, H. Kimura, S. Takagishi, T. Shirakawa and K. Tada 408
Annealing effects on hydrogen passivation of Zn acceptors in AlGaInP with p-GaAs cap layer grown by metalorganic vapor phase epitaxy
A. Ishibashi, M. Mannoh and K. Ohnaka 414
The presence of isolated hydrogen donors in heavily carbon-doped GaAs
H. Fushimi and K. Wada 420
Ti doping of InP and GaInAs using $TiCl_4$
C. Caneau, R. Bhat, S.A. Schwarz, M.A. Koza, C.E. Zah, D.M. Hwang, A. Rajhel and C. Chen 427
Nitrogen doping in AlGaP grown by organometallic vapor phase epitaxy using tertiarybutylamine as nitrogen source
A. Wakahara, K. Hirano, T. Kaneko and A. Sasaki 435
Heavy carbon doping in low-pressure metalorganic vapor phase epitaxy of GaAs using trimethylarsenic – a comparison between the carrier gases N_2 and H_2
H. Hardtdegen, Chr. Ungermanns, K. Wirtz, D. Guggi, J. Herion, H. Siekmann and H. Lüth 440
Silicon delta-doped AlGaAs by low pressure metalorganic vapor phase epitaxy
D.M. Ritchie, A. Di Paola, M. Tromby, M. Dellagiovanna, M. Di Egidio and F. Vidimari 447
Novel ways to grow thermally stable semi-insulating InP-based layers (invited paper)
D. Bimberg, A. Dadgar, R. Heitz, A. Knecht, A. Krost, M. Kuttler, H. Scheffler, A. Näser, B. Srocka, T. Wolf, T. Zinke, J.Y. Hyeon, S. Wernik and H. Schumann 455
Electrical characterization of semi-insulating metalorganic vapor phase epitaxy GaAs grown by controlled oxygen incorporation
J.W. Huang and T.F. Kuech 462

SECTION VI. NEW PRECURSORS

Metalorganic vapor phase epitaxy using organic group V precursors (invited paper)
J. Komeno 468
Ab initio study on the dimer structures of trimethylaluminum and dimethylaluminumhydride
Y.S. Hiraoka and M. Mashita 473
A new approach towards low-pressure metalorganic vapor phase epitaxy of (AlGa)As using triethylgallium and dimethylethylaminealane
H. Hardtdegen, Chr. Ungermanns, M. Hollfelder, T. Raafat, R. Carius, St. Hasenöhrl and H. Lüth 478
Criteria for the design of monoalkylphosphine precursors for InP metalorganic vapour phase epitaxy
H.H. Abdul-Ridha, J.E. Bateman, R.C. Crowte, P. Hoye, A.C. Jones, R. Padda, D.G. Patrikarakos and M.E. Pemble 485
Growth of GaInAsSb using tertiarybutylarsine as arsenic source
M. Sopanen, T. Koljonen, H. Lipsanen and T. Tuomi 492
The growth of $GaAs/Al_xGa_{1-x}As$ with $DEAlH–NMe_3$ as Al source and MEAs and DMAAs as liquid As compounds
R. Hövel, E. Steimetz and K. Heime 498
Developments in metalorganic precursors for vapour phase epitaxy
A.C. Jones 505
GaAs substrate pretreatment and metalorganic vapour phase epitaxy of GaAs, AlAs and (AlGa)As using β-elimiinating trialkyl-As precursors
G. Zimmermann, Z. Spika, T. Marschner, B. Spill, W. Stolz, E.O. Göbel, P. Gimmnich, J. Lorberth, A. Greiling and A. Salzmann 512

Mechanisms of decomposition of group VI dialkyls and alkylhydrides in the gas phase from studies of designed precursors
D.F. Foster, W. Bell, J. Stevenson, D.J. Cole-Hamilton and J.E. Hails 520

SECTION VII. GROWTH OF II–VI SEMICONDUCTORS

New allyl selenide and trialkylphosphine selenide precursors for metalorganic vapor phase epitaxy of ZnSe (invited paper)
M. Danek, J.-S. Huh, L. Foley and K.F. Jensen 530
Epitaxial growth of ZnMgSSe on GaAs substrate by metalorganic chemical vapor deposition
A. Toda, T. Asano, K. Funato, F. Nakamura and Y. Mori 537
Metalorganic vapour phase epitaxy growth of $Zn_{1-x}Mg_xTe$ layers
B. Qu'Hen, R. Helbing, W.S. Kuhn, J.E. Bourée, A. Lusson and O. Gorochov 541
Misfit dislocation microstructure and kinetics of HgCdTe/CdZnTe under tensile and compressive stress
L. Sugiura, K. Shigenaka, F. Nakata and K. Hirahara 547
Metalorganic vapor-phase epitaxy of p-type ZnSe and p/n junction diodes (invited paper)
Sz. Fujita and Sg. Fujita 552
Novel nitrogen source materials in zinc selenide metalorganic chemical vapor deposition
A. Kamata 557
Cathodoluminescence characterization of nitrogen-doped ZnSe
B. Bollig, M. Blauermel, W. Taudt and M. Heuken 562
Metalorganic vapor phase epitaxy growth and nitrogen-doping of $Zn_xCd_{1-x}S$ using photo-assistance
H. Dumont, Sz. Fujita and Sg. Fujita 570
Photoluminescence properties of ZnTe layers grown by photo-assisted metalorganic vapor phase epitaxy
S.I. Gheyas, M. Ikejiri, T. Ogata, H. Ogawa and M. Nishio 576
Low-temperature growth and nitrogen doping of ZnSe using diethylzinc and ditertiarybutylselenide in a plasma-stimulated low-pressure metalorganic vapour phase epitaxy system
W. Taudt, B. Wachtendorf, R. Beccard, A. Wahid, M. Heuken, A.L. Gurskii and K. Vakarelska 582
Misfit dislocation arrangements at $(Hg_xMn_{1-x})Te/CdTe$ and $(Hg_xMn_{1-x})Te/CdZnTe$ heterointerfaces on (001), $(\overline{111})B$ and $(\overline{112})B$ substrates
H. Tatsuoka, K. Durose and M. Funaki 589
Methyl(allyl)telluride as a Te precursor for growth of (Hg,Cd)Te by metalorganic vapour phase epitaxy
J.E. Hails, D.J. Cole-Hamilton and W. Bell 596
Crystalline quality and interface sharpness of $ZnSe/ZnS_xSe_{1-x}$ superlattices on GaAs: analysis by Raman spectroscopy and X-ray diffractometry
J. Geurts, J. Woitok, J. Hermans, W. Schiffers, M. Scholl, J. Söllner and M. Heuken 602
Homogeneity of ZnSSe/ZnSe multiquantum wells grown by metalorganic vapour phase epitaxy
J. Söllner, M. Scholl, J. Schmoranzer, A. Wahid, M. Heuken, J. Woitok, J. Hermans, W. Schiffers and J. Geurts 609
Metalorganic vapor phase epitaxial growth of GaAs on ZnSe; on the flow sequence of source precursors at the interface
M. Funato, Sz. Fujita and Sg. Fujita 616

SECTION VIII. GROWTH SYSTEMS

Highly uniform InGaAsP growth by dual-fluid-layer structure metalorganic vapor phase epitaxy reactor with atmospheric pressure
T. Matsumoto and T. Nakamura 622
Modelling of growth in a 5×3 inch multiwafer metalorganic vapour phase epitaxy reactor
T. Bergunde, F. Durst, L. Kadinski, Yu.N. Makarov, M. Schäfer and M. Weyers 630
Aerosol particles from metalorganic vapor phase epitaxy bubblers
K. Deppert, H.-C. Hansson, S. Jeppesen, M.S. Miller, L. Samuelson, W. Seifert and A. Wiedensohler 636
Thermal and flow issues in the design of metalorganic chemical vapor deposition reactors
A.I. Gurary, G.S. Tompa, A.G. Thompson, R.A. Stall, P.A. Zawadzki and N.E. Schumaker 642
Multi-wafer growth of highly uniform and high-quality AlGaInP/GaInP structure using high-speed rotating disk metalorganic chemical vapor deposition
T. Motoda, M. Kato, K. Kadoiwa, A. Shima, M. Tsugami, T. Sonoda, T. Takamiya and S. Mitsui 650

Design and operating characteristics of a metalorganic vapor phase epitaxy production scale, vertical, high speed, rotating disk reactor
G.S. Tompa, P.A. Zawadzki, K. Moy, M. McKee, A.G. Thompson, A.I. Gurary, E. Wolak, P. Esherick, W.G. Breiland, G.H. Evans, N. Bulitka, J. Hennessy and C.J.L. Moore 655
Metalorganic chemical vapor deposition of high-quality and highly uniform strained InGaAs quantum wells in a high-speed rotating-disk reactor
S. Karakida, M. Miyashita, A. Shima, N. Kaneno, Y. Mihashi, S. Takamiya and S. Mitsui 662

SECTION IX. CHEMICAL BEAM EPITAXY

Metalorganic molecular beam epitaxy and etching of GaAs and GaSb using trisdimethylaminoarsenic and trisdimethylaminoantimony
H. Asahi, X.F. Liu, K. Inoue, D. Marx, K. Asami, K. Miki and S. Gonda 668
Extremely smooth vertical facets of InP formed by reactive ion etching and selective chemical beam epitaxy regrowth
M. Gotoda, H. Sugimoto, S. Maruno, T. Isu, W. Susaki and M. Nunoshita 675
Monolayer control of chemical beam etching
W.T. Tsang, T.H. Chiu, R.M. Kapre and J.F. Ferguson 680
Carbon gettering mechanism of GaAs chemical beam epitaxy using trisdimethylamino-arsine and trimethylgallium
K. Ishikura, A. Takeuchi, M. Kurihara, M. Nakagawa and F. Hasegawa 687

SECTION X. LOW-DIMENSIONAL STRUCTURES AND INTERFACES

X.A. Quantum wires and dots

Formation and photoluminescence characterization of quantum well wires using multiatomic steps grown by metalorganic vapor phase epitaxy
S. Hara, J. Ishizaki, J. Motohisa, T. Fukui and H. Hasegawa 692
GaInAs/InP organometallic vapor phase epitaxy regrowth for ultrafine buried heterostructures with 50 nm pitch toward electron wave devices
M. Suhara, Y. Miyamoto, H. Hongo, J. Suzuki and K. Furuya 698
Metalorganic vapor phase epitaxial growth and luminescence properties of GaAs/GaAsP quantum wires
W. Pan, H. Yaguchi, K. Onabe, K. Wada, Y. Shiraki and R. Ito 702
Growth of GaAs microcrystal by Ga droplet formation and successive As supply with low-pressure metalorganic chemical vapor deposition
T. Ueda, Q.Z. Gao, E. Yamaichi, C. Yamagishi and M. Akiyama 707
Preparation of II–VI quantum dot composites by electrospray organometallic chemical vapor deposition
M. Danek, K.F. Jensen, C.B. Murray and M.G. Bawendi 714
Formation of coherently strained self-assembled InP quantum islands on InGaP/GaAs(001)
S.P. DenBaars, C.M. Reaves, V. Bressler-Hill, S. Varma and W.H. Weinberg 721
Vertically-stacked GaAs quantum wires grown on Si substrates by metalorganic chemical vapor deposition
Y. Hasegawa, T. Egawa, T. Jimbo and M. Umeno 728
Fabrication of quantum wire structures by in-situ gas etching and selective-area metalorganic vapor phase epitaxy regrowth
K. Shimoyama, S. Nagao, Y. Inoue, K. Kiyomi, N. Hosoi, K. Fujii and H. Gotoh 734

X.B. Quantum wells

Ordering in strained $Ga_xIn_{1-x}P$ quantum wells grown by metalorganic vapor phase epitaxy
C. Geng, M. Moser, R. Winterhoff, E. Lux, J. Hommel, B. Höhing, H. Schweizer and F. Scholz 740
Characterization of GaP/InGaP and GaP/GaAsP strained-layer quantum wells grown by metalorganic chemical vapor deposition
J.G. Neff, M.R. Islam, R.V. Chelakara, K.G. Fertitta, F.J. Ciuba and R.D. Dupuis 746
Relaxation process in strained InGaAs/InP quantum wells studied by X-ray topography
K. Mukai, M. Sugawara and S. Yamazaki 752
Metalorganic vapour phase epitaxy grown quantum-well structures within barriers of InP and GaInP – a comparison
W. Seifert, N. Carlsson, M.-E. Pistol and L. Samuelson 758

Elimination of wavy layer growth phenomena in strain-compensated GaInAsP/GaInAsP multiple quantum well stacks
R.W. Glew, K. Scarrott, A.T.R. Briggs, A.D. Smith, V.A. Wilkinson, X. Zhou and M. Silver 764
Low-pressure metalorganic vapour phase epitaxy growth of InAs/GaAs short period superlattices on InP substrates
A. Lindner, Q. Liu, F. Scheffer, M. Haase, W. Prost and F.J. Tegude 771
Growth of InAs/GaSb strained layer superlattices. I
G.R. Booker, P.C. Klipstein, M. Lakrimi, S. Lyapin, N.J. Mason, R.J. Nicholas, T.-Y. Seong, D.M. Symons, T.A. Vaughan and P.J. Walker 778

X.C. Interfaces

Interface characteristics of GaInP/GaAs double heterostructures grown by metalorganic vapor phase epitaxy
C.Y. Tsai, M. Moser, C. Geng, V. Härle, T. Forner, P. Michler, A. Hangleiter and F. Scholz 786
The effect of controlled impurity incorporation on interfacial roughness in GaAs/$Al_xGa_{1-x}As$ superlattice structures grown by metalorganic vapor phase epitaxy
J.M. Redwing, S. Nayak, D.E. Savage, M.G. Lagally, D.F. Dawson-Elli and T.F. Keuch 792
Effect of strained InGaAs step bunching on mobility and device performance in n-InGaP/InGaAs/GaAs pseudomorphic heterostructures grown by metalorganic vapor phase epitaxy
T. Kikkawa, K. Makiyama, H. Ochimizu, K. Kasai and J. Komeno 799
Zn diffusion mechanism in n-GaAs/Zn–AlGaAs/Se–AlGaAs structures
N. Fujii, T. Kimura, M. Tsugami, T. Sonoda, S. Takamiya and S. Mitsui 808
Characterization of the interface abruptness of $In_{0.53}Ga_{0.47}As$/InP multi quantum wells by Raman spectroscopy, X-ray diffractometry and photoluminescence
J. Geurts, J. Finders, J. Woitok, D. Gnoth, A. Kohl and K. Heime 813
Effect of growth interruption on the interface flatness in metalorganic vapor phase epitaxy-grown GaAs/GaAsP heterostructures
K. Ota, H. Yaguchi, K. Onabe, R. Ito and Y. Shiraki 819

XI. DEVICES

XI.A. Lasers and light-emitting diodes

Growth and doping properties of AlGaAs/GaAs/InGaAs structures on nonplanar substrates for applications to low threshold lasers
H. Zhao, K. Uppal, M.H. MacDougal, P.D. Dapkus, H. Lin and D.H. Rich 824
Metalorganic chemical vapor deposition grown AlGaAs lasers with grown optical facets
Y. Marutani, H. Narui, K. Nemoto, Y. Higuchi, T. Kobayashi and O. Matsuda 832
Metalorganic vapor phase epitaxial growth of red and infrared vertical-cavity surface-emitting laser diodes
R.P. Scheider, Jr., J.A. Lott, K.L. Lear, K.D. Choquette, M.H. Crawford, S.P. Kilcoyne and J.J. Figiel 838
Monolithically integrated multi-wavelength MQW–DBR laser diodes fabricated by selective metalorganic vapor phase epitaxy
T. Sasaki, M. Yamaguchi and M. Kitamura 846
Low threshold $\lambda = 1.3\ \mu m$ multi-quantum well laser diodes grown by metalorganic vapor phase epitaxy using tertiarybutylarsine and tertiarybutylphosphine precursors
S. Ae, T. Terakado, T. Nakamura, T. Torikai and T. Uji 852
High-performance 1.3 μm AlGaInAs/InP strained quantum well lasers grown by organometallic chemical vapor deposition
R. Bhat, C.E. Zah, M.A. Koza, B. Pathak, F. Favire, W. Lin, M.C. Wang, N.C. Andreadakis, D.-M. Hwang, T.P. Lee, Z. Wang, D. Darby, D. Flanders and J.J. Hsieh 858
New structure by selective regrowth in multi-quantum well laser diodes performed by low pressure metalorganic vapor phase epitaxy
N. Otsuka, M. Kito, Y. Mori, M. Ishino and Y. Matsui 866
Monolithic integration of a single quantum well laser diode and a mode-size convertor using shadow-masked metalorganic vapour phase epitaxial growth
G. Vermeire, F. Vermaerke, I. Moerman, J. Haes, R. Baets, P. Van Daele, P. Demeester, A. Gustafsson and L. Samuelson 875

Fabrication of $Al_xGa_{1-x}As$ buried heterostructure laser diodes by in-situ gas etching and selective-area metalorganic vapor phase epitaxy
Y. Inoue, K. Shimoyama, K. Fujii, N. Hosoi and H. Gotoh 881
Metalorganic vapor phase epitaxy growth of InGaAsP multi quantum well laser diodes using entirely organic sources
M. Horita, M. Tsurusawa, K. Utaka and Y. Matsushima 886
Improvement of crystal quality and laser characteristics by zero net strain structure
T. Takiguchi, K. Goto, M. Takemi, A. Takemoto, T. Aoyagi, H. Watanabe, Y. Mihashi, S. Takamiya and S. Mitsui 892
Drastic improvement of Zn doping characteristics in p-AlAs grown by metalorganic chemical vapor deposition for low-resistance vertical-cavity surface-emitting lasers
T. Mukaihara, H. Maekawa, Y. Hayashi, N. Ohnoki, F. Koyama and K. Iga 898
Integrated DFB–DBR laser modulator grown by selective area metalorganic vapor phase epitaxy growth technique
T. Tanbun-Ek, Y.K. Chen, J.A. Grenko, E.K. Byrne, J.E. Johnson, R.A. Logan, A. Tate, A.M. Sergent, K.W. Wecht, P.F. Sciortine, Jr. and S.N.G. Chu 902
Effect of growth interruption on performance of AlGaAs/InGaAs/GaAs quantum well lasers
F. Bugge, G. Beister, G. Erbert, S. Gramlich, I. Rechenberg, H. Treptow and M. Weyers 907
Zn-doped InGaN growth and InGaN/AlGaN double-heterostructure blue-light-emitting diodes (invited paper)
S. Nakamura 911
Low-pressure metalorganic vapor phase epitaxy of ZnSe-based light emitting diodes
H. Stanzl, K. Wolf, B. Hahn and W. Gebhardt 918

XI.B. Electronic devices and electrical characteristics

Novel pseudomorphic structure on Si substrate grown by metalorganic vapor phase epitaxy
T. Ohori, T. Eshita, S. Miyagaki, K. Kasai and J. Komeno 924
Precise control of lattice strain in carbon-doped GaAs by indium co-doping for reliable AlGaAs/GaAs heterojunction bipolar transistors
N. Watanabe, T. Nittono and H. Ito 929
Metalorganic molecular beam epitaxial growth of InP and InGaP with tertiarybutylphosphine for the application of carbon-doped base heterojunction bipolar transistors
J. Shirakashi, R.T. Yoshioka, T. Azuma, F. Fukuchi, M. Konagai and K. Takahashi 935
Evaluation of p–n junction shift by the capacitance–voltage method
N. Yamamoto and M. Yamamoto 941
Performance comparison of metalorganic vapor phase epitaxy grown C-doped GaAs/AlGaAs heterojunction bipolar transistor wafers between AsH_3 and trimethylarsenic for the base layer growth
S. Tanaka, S. Kato, S. Hattori, S. Kojima, M. Ikeda and K. Kitamura 947
Growth and characterization of two-dimensional electron gas InGaP/GaAs heterostructures grown by low-pressure metalorganic chemical vapour deposition using tertiarybutylarsine and tertiarybutylphosphine
C. Jagadish, A.A. Allerman, N. Hauser, C.C. Hsu and M. Gal 953
Two-dimensional electron gases in low-pressure metalorganic vapour phase epitaxially grown InGaP homojunctions
P.R. Hageman, F.A.J.M. Driessen, G.J. Bauhuis and L.J. Giling 958
High resistivity undoped $Al_{0.48}In_{0.52}As$ layers grown by low-temperature metalorganic chemical vapor deposition
T. Kimura, S. Ochi, N. Fujii, T. Ishida, T. Sonoda, S. Takamiya and S. Mitsui 963

SECTION XII. LATE NEWS ABSTRACTS

High-purity AlGaAs from methyl-based precursors using in-situ gettering of alkoxides
J.S. Roberts and J.P.R. David 968
MOCVD growth on AlGaAs substrates
Y. Kohama, Y. Ohiso, K. Tateno, C. Amano and T. Kurokawa 970
Ultra-high uniformity large-area growth of GaAs/AlGaAs structures by low-pressure MOVPE
E. Woelk, J. Ermer, G. Strauch, P.S. Vijayakumar, D. Schmitz, T. Cavicchi and H. Jürgensen 972
Fast evolution of surface dynamics during epitaxy of GaAs on c(4 × 4) reconstructed surface
S. Zhang, J. Cui, A. Tanaka and Y. Aoyagi 974
Rectangular shaped quantum wire fabrication by growth mode switching between isotropic and anisotropic atomic layer epitaxy
H. Isshiki, S. Iwai, T. Meguro, Y. Aoyagi and T. Sugano 976

Investigations on the compositional non-uniformity of selectively grown $Ga_xIn_{1-x}P$ by LP-MOCVD using EDMI, TMI TEG, and TMG as group III sources
S.-H. Chan, C.-Y. Chang and S.M. Sze 978
Temperature dependent facet development of LP-MOCVD InGaP grown on patterned GaAs substrates
M.M.G. Bongers, P.L. Bastos and L.J. Giling 981
LP-MOCVD grown GaInP/GaAs HBTs for VCOs and power amplifier MMICs
M.A. di Forte-Poisson, C. Brylinski, S.L. Delage, H. Blanck, D. Floriot, S. Cassette, E. Chartier and D. Pons 983
Highly uniform InGaAs quantum dots (~ 15 nm) grown by MOVPE on GaAs
J. Oshinowo, M. Nishioka, S. Ishida and Y. Arakawa 986
Photoluminescence of buried InGaAs grown on nanoscale InP islands by MOVPE
H. Lipsanen, J. Ahopelto, T. Koljonen and M. Sopanen 988
Strained InGaAs quantum wire and box structure self-organized on high-index GaAs (*n*11)A and (*n*11)B substrates
R. Nötzel, J. Temmyo and T. Tamamura 990

Author index 992
Subject index 1006